DUROTERRA™

FALL WEBINAR
DUCTILE IRON PILES: AN INSIDE LOOK



The following questions were posed during the DuroTerra "Ductile Iron Piles – A Piling Alternative for Challenging Sites" webinar presented on Thursday, November 19, 2020. Responses to the questions are also listed. For additional information, please do not hesitate to contact us at info@duroterra.com.

1. *IS A DOMESTICALLY PRODUCED PRODUCT AVAILABLE THAT COULD BE USED ON PUBLIC PROJECTS THAT HAVE BUY AMERICA(N) REQUIREMENTS?*

Unfortunately, no domestically manufactured options are currently available. While we continue to investigate this possibility for U.S.-based manufacturing, the manufacturer of our Ductile Iron Pile system is based in Austria and does not meet Buy America requirements often in place for transportation and infrastructure projects. The system does originate from a country meeting the Trade Agreement Act and typically allowed on certain federal projects including military work. Please consult the specific project requirements and contact DuroTerra with questions.

2. *THE LARGEST CROSS SECTION YOU SHOWED IS ABOUT 10 SQ. IN, IF F_y IS 46 KSI AND CODE ALLOWS 30 TO 40% OF YIELD FOR DESIGN LOAD, HOW DO YOU GET TO A DESIGN LOAD OF 120 TONS? SEEMS MAX IS ON THE ORDER OF 90 TONS?*

The largest pile section is a Series 170/13 which has a 170 mm (6.7 inch) O.D. and a 13 mm (0.51 inch) wall thickness. This equates to an area of just under 10 in^2. An allowable value of 120 tons is permitted based on using an allowable stress factor of 0.50 (per IBC Table 1810.3.2.6) resulting in a maximum permissible stress of 23.2 ksi (F_y < 32 ksi) provided a full-scale load test is performed.

3. *HAS DYNAMIC LOAD TESTING (PDA) BEEN PERFORMED ON THIS TYPE OF PILE?*

The majority of our testing on the system has been performed using full-scale static load testing (compression or tension). However, dynamic testing has been performed on Ductile Iron Piles on isolated projects. Based on our experience, the high-frequency percussion hammers used for pile driving do not typically deliver enough energy per blow to generate sufficient tip movement to confirm design values. Instead, a drop-weight set-up or alternative hammer is required. We have worked on projects where GRL has applied their Apple system to effectively perform PDA testing. Similar setups have been used extensively in Europe to test the system.

4. *PER IBC, A LOAD TEST IS REQUIRED FOR LOADS OVER 40 TONS. WHAT TYPE OF LOAD TEST IS TYPICAL? STATIC LOAD TEST WITH HELICAL ANCHORS OR DEADWEIGHT?*

Most testing performed on the system to-date has involved traditional full-scale static load tests based on ASTM D-1143 (compression) or ASTM D-3689 (tension). Test reactions are typically accomplished using exterior grouted friction Ductile Iron Piles with high-strength threadbar inserted into the grouted pile for tension resistance. Helical piles could also be used and offer the benefit of removing them after testing. On limited occasions with very deep, soft soils, a gravity-reaction test setup has been implemented. Finally, some projects have also implemented STATNAMIC™ testing to verify performance.

5. *WHEN YOU REFER TO "PILE CAPACITY", AM I RIGHT TO ASSUME YOU MEAN "ALLOWABLE COMPRESSION LOAD"?*

References to "pile capacities" ranging from 25 tons up to 120 tons is more accurately the allowable structural compression load of the pile. Alternatively, allowable tension loads are often in the range of 5 ton to 50 tons and will depend on the size of the high-strength center bar.

6. *HOW IS PRE-DRILLING PERFORMED IN RUBBLE FILL ZONES? WHO TYPICALLY DOES THIS?*

The Ductile Iron Pile system is typically a displacement pile application and does not require pre-drilling be performed. There are many example projects (www.duroterra.com/projects/) where the system has penetrated through dense / debris fills. However, on occasion as highlighted in the Alta XMBLY project summary during the presentation, it may be necessary or desirable to perform a hybrid approach of pre-drilling to core through an existing concrete structure (footing or slab) or create a hole through a heavily obstructed debris fill followed by driving Ductile Iron Piles. This work would need to be performed by the Ductile Iron Pile installer or in close coordination with a third-party drilling subcontractor. We have had projects where both scenarios have occurred. This determination will depend on the pile installer's capabilities.

7. WHAT IS THE TYPICAL UNIT PRICE OF THIS TYPE OF PILE? $10/FT? $50/FT?

Material pricing will depend on the pile size and wall thickness but varies from approximately $19/ft to $38/ft. We're pleased to work with you to evaluate project feasibility and provide a corresponding material quote.

8. CAN CUSTOM SHORTER LENGTH DIP SECTIONS BE MANUFACTURED FOR LOW HEADROOM CONDITIONS?

Ductile Iron Piles can absolutely accommodate low head-room conditions. Rather than manufacturing in smaller length sections, the piles are cut in the field and a drive-on coupler is used. The drive-on coupler acts in the same fashion as the manufactured bell to connect the sections. It is most common to cut the 16-foot pile sections in half with lengths of approximately 8 feet although additional cutting is feasible. The system is ideally suited for overhead clearances above about 18 feet. If clearances are less than 18 feet, it may be difficult to fit the hammer/excavator into the space. Overhead clearance limitations will depend on the DIP installer's specific equipment. The general rule-of-thumb is that a pile installed with about 26 to 28 feet of overhead clearance or more does not typically require any cutting or the use of couplers.

9. WHAT IS THE MATERIAL PRICING FOR THE DIFFERENT DIAMETERS OF THE DIP?

Please see the response to Question 7 above.

10. DID YOU HIGHLIGHT THE PIPE TO GROUT BOND CAPACITY FOR FRICTION PILES? DOES THE RELATIVELY SMOOTH IRON PIPE EFFECTIVELY BOND TO THE GROUT?

Unlike the smooth surface of a steel pipe pile or steel H-pile, the manufacturing process of the Ductile Iron Pile results in a roughened outer surface to the pile. As such, the grout on the interior (and exterior) of the pile bonds extremely well to the pile surface. Through all of our testing, we have found that the limiting capacity of any friction Ductile Iron Pile is dictated by the grout-to-ground bond capacity as opposed to the grout-to-pile bond capacity.

11. ALSO, PRICING ON THE DIFFERENT DRIVING SHOES AND GROUT SWIVEL?

The price of the driving shoes ranges from about $11 to $135 per shoe depending on the type and size. The drive accessories (shanks, grout boxes, etc) range from about $2,000 to $5,500 depending on the type of tool. Please contact DuroTerra to evaluate project feasibility and for a corresponding material quote

12. WHAT IS THE MINIMUM VERTICAL CLEARANCE TO INSTALL DIPs?

See Question 8

13. WHAT WOULD NOT BE FEASIBLE APPLICATIONS FOR DIPs?

Like all pile systems, Ductile Iron Piles may not be the best option for all sites. For instance, a project requiring very high capacity piles (>120 tons) will not be feasible using Ductile Iron Piles unless additional lower capacity piles are supplemented. A traditional micropile project with shallow rock where large tension demands are required is also not likely feasible for Ductile Iron Piles since the DIPs will set on the rock and not achieve high tension loads. Another example is a project where rock is relatively shallow and piles need to penetrate a heavily-obstructed (i.e. buried foundations that require drilling) fill. While it may be feasible for DIPs with additional pre-drilling operations, this is often a better micropile project since you'd have to drill through the debris and then be at the rock for socketing.

14. ARE DIPs A SAFE SYSTEM FOR USE AS END BEARING PILES IN A KARST GEOLOGIC SETTING?

The use of Ductile Iron Piles (or any driven pile system) in a Karst geologic setting will depend on the risk level at the particular site and risk level of the owner. The DIPs are moderate capacity piles and have the advantages of driving into weathered rock to achieve "set" and know that the pile is bearing on competent material. However, terminating on thin rock shelves may be a concern. In these conditions, pile capacity can be reduced. In addition, utilizing exterior grout can also provide additional pile capacity and localized grouting to aid in the redundancy of the system. Ultimately though, if the project is located on a very high-risk site and the owner is looking for a minimal risk solution, then drilled shafts or micropiles are the better (yet more expensive) option.

15. FOR FRICTION PILES, IS THERE A MINIMUM DRIVING ENERGY THAT MUST BE MET IN ORDER TO ACHIEVE A PROPER COLD WELD AT THE JOINTS?

The piles must be driven with a minimum amount of energy (time) to close the joint and develop the moment-resisting connection. Our research using tension tests to evaluate joint integrity has found that only about 5 seconds of driving is required for the upper pile section to drive into the lower bell to form the connection. Practically, this is never an issue to achieve this minimum rate of driving because even a friction pile is always terminating in a competent material for bonding which requires greater amount of driving energy and time than 5 seconds to develop the connections throughout the pile.